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The Preparation of ACEL Thin Films

by

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The 1st Periodic Report

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MOCVD Thin Films for ACTFEL Devices

1.0.0 Introduction

It has been demonstrated that MOCVD is capable of yielding ZnS.Mn thin films suitable for electroluminescent device applications. Recent research has shown that such films, in a DC operated composite device, have excellent maintenance characteristics and are superior to sputtered or evaporated films. It is, therefore, the purpose of this programme to fabricate ZnS.Mn thin films for assessment in ACTFEL devices, and, during the course of a more expansive programme, investigate the MOCVD method for the deposition of the insulating layers in addition to the light emitting layer.

Zinc Sulfides, (MgMn) ←

2.0.0 The Present Position

2.1.0 Organometallic Vapour Source Synthesis

2.1.1 Working quantities of Zn $[(C_2H_5)_2NCS_2]_2$ have been synthesised and the product purified by partition and recrystallisation methods. This material will be the principal ZnS vapour source for low pressure metallorganic chemical vapour deposition (LPMOCVD) activities. Samples of Zn(xant)₂ have been synthesised for the aerosol spray pyrolysis system (ASP).

2.1.2 New manganese vapour source materials are now under investigation, in particular, the derivatives of $R_2NCS_2^-$ for application in LPMOCVD. These source materials will also be examined in the ASP system.

Quantities of tri-carbonyl methyl cyclopentadienyl manganese (TCM) have been purchased. This can only be purchased as a technical grade material and is being purified by reduced pressure distillation for application in the LPMOCVD and ASP activities.

2.1.3 Materials have been purchased for synthesis and/or direct application in the insulating layer deposition process.

2.2.0 MOCVD Systems Development

2.2.1 Initial Considerations

Much of our previous MOCVD work for ZnS.Mn depositions have been carried out in a conventional atmospheric pressure hot-wall system with the vapour derived directly from the heated source. For improved control and the maximum potential for large area, high volume panel fabrication, two deposition systems appear to be advantageous for further investigation:

- (i) a low pressure deposition system (LPMOCVD) with multiple stacked substrates in a vertical or horizontal hot-wall reactor, and,
- (ii) an aerosol spray pyrolysis system (ASP). Initially, an horizontal reactor will be employed, with the option of horizontally stacked substrates in a multi-channel flow reactor.

2.2.2 LPMOCVD

Two medium size LPMOCVD horizontal hot-wall reactors have been constructed (fig. 1). One system will operate with a horizontal substrate platform for initial evaluation of organometallic source materials, the other will be used to carry out a preliminary evaluation of reactor conditions with vertically stacked substrates. The stacking system has been designed (figs. 1-3) but work has not yet begun on its construction. A low pressure TCM container has been designed and is currently under construction.

2.2.3 ASP

A simple multi-channel ASP reactor is currently under construction, the basic reactor design being shown in fig. 4. A vapour generating system has been set up, fig. 5, and various solution systems examined for a preliminary assessment of their vapour generating and transport characteristics.

3.0.0 Thin Film Deposition

3.1.0 LPMOCVD

Preliminary thin film depositions have been carried out for ZnS from $\text{Zn}(\text{Et}_2\text{NCS}_2)_2$ with an N_2 carrier gas and pressures in the range 1-10 torr. ZnS thin films are being deposited at $\sim 400^\circ\text{C}$.

3.2.0 ASP

Initial trials with $\text{Zn}(\text{xant})_2$ in DMF and similar solvents have proven to be very successful. ZnS thin films can be deposited at $\sim 200^\circ\text{C}$ using an N_2 carrier gas and with good uniformity (visual inspection of interference patterns). It should be noted that this deposition temperature is near the lower working limit when amorphous ZnS will be obtained.

4.0.0 Research Plans (Performance Period 1st December 1987-15th January 1988)

4.1.0 Organometallic Source Synthesis

Further work on the synthesis and purification of zinc and manganese dithiocarbamates. Samples to be fully characterised by AA (for purity) and DTA/TGA for thermal characteristics. Further work on the preparation, purification and thermal characterisation of the zinc xanthates is to be carried out. Synthesis and/or characterisation of organometallic materials for insulating oxide layers is to be carried out and an initial assessment made of vapour generation and transport properties.

4.2.0 MOCVD Systems Development

4.2.1 LPMOCVD

Vertically stacked substrate cassette to be constructed.

4.2.2 ASP

Construction of two ASP systems to be completed and initial deposition trials carried out for (a) ZnS.Mn and (b) insulating oxide thin films.

4.3.0 Device Operation and Evaluation

Plans to be drawn up for complete device fabrication, AC operation and performance assessment.

LPMOCVD SYSTEM

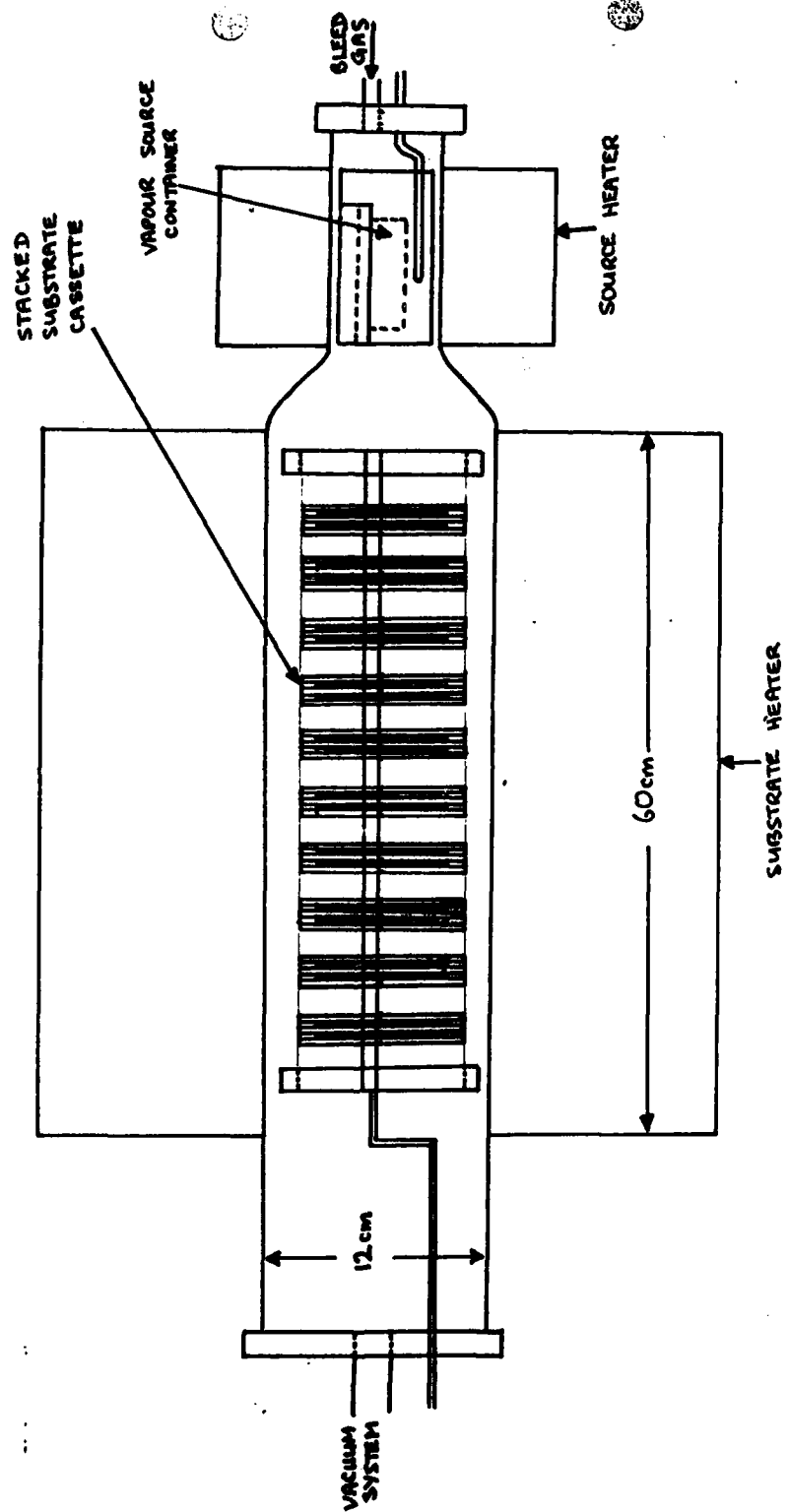


Fig 1.

SUBSTRATE HOLDER

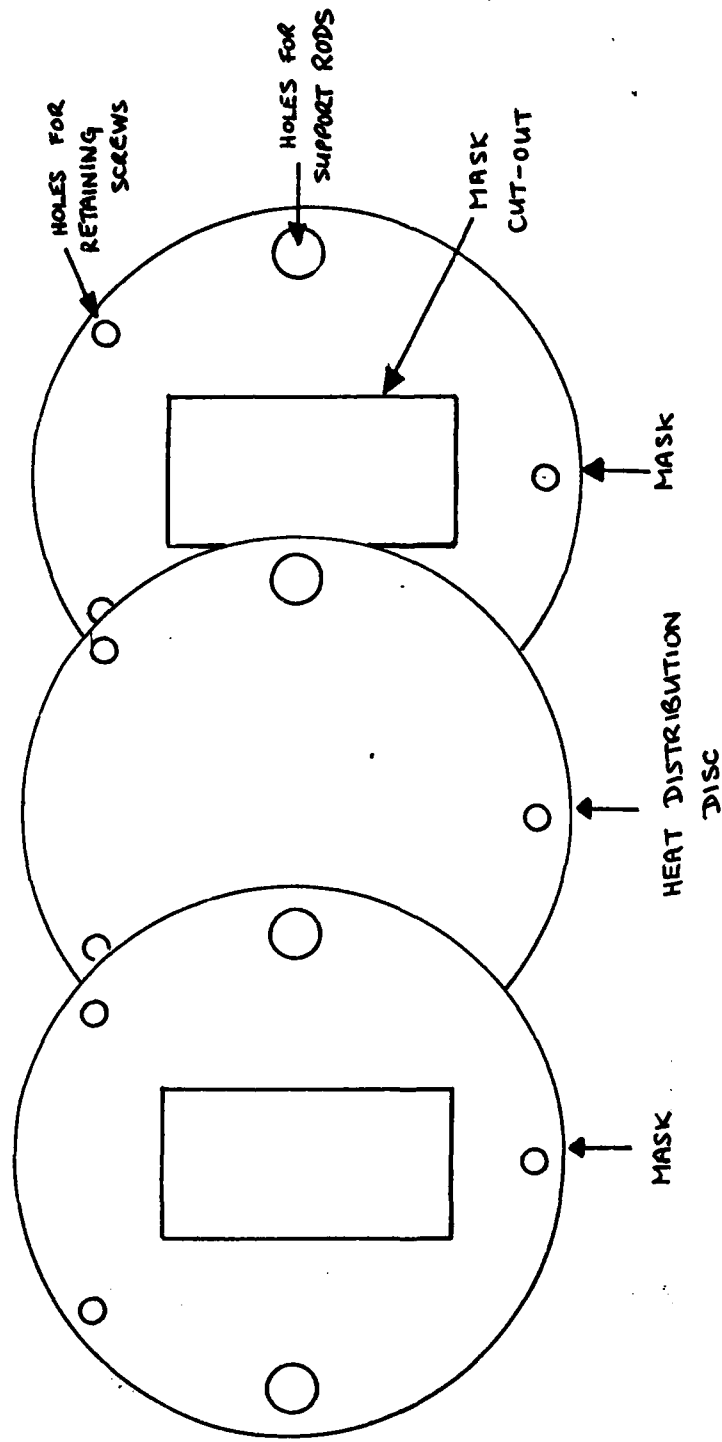


Fig. 2.

SUBSTRATE HOLDER UNIT

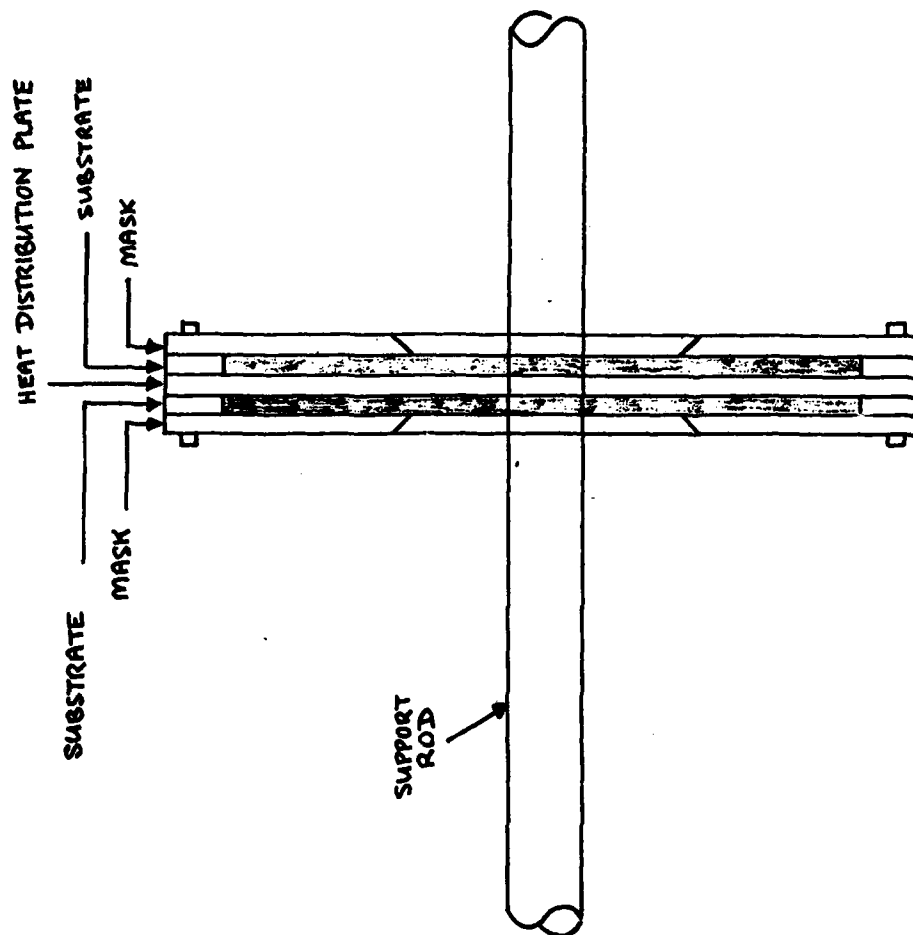


Fig. 3.

ASP - MULTI-CHANNEL DEPOSITION SYSTEM

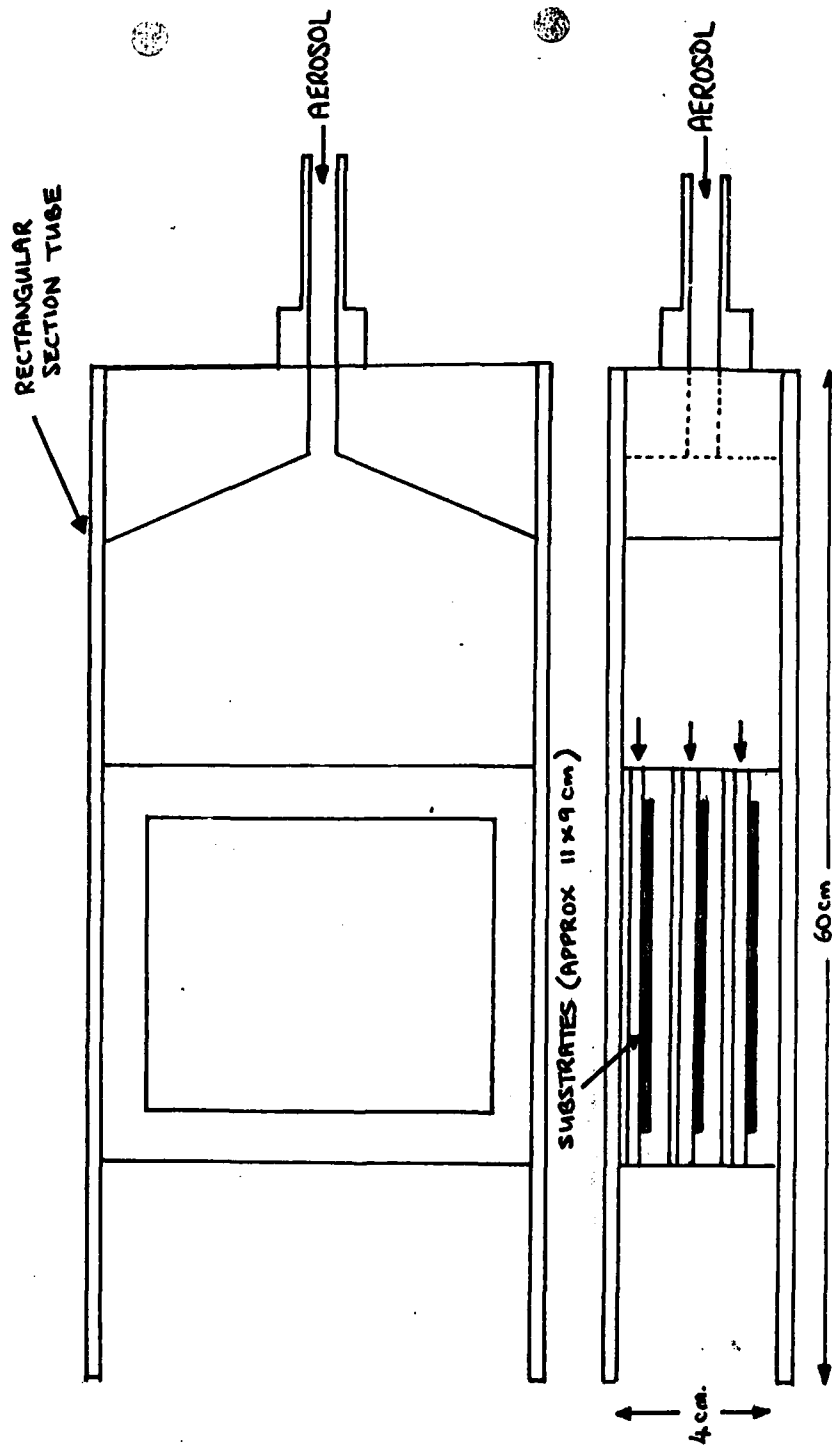


Fig. 4.

ASP - VAPOUR GENERATING SYSTEM

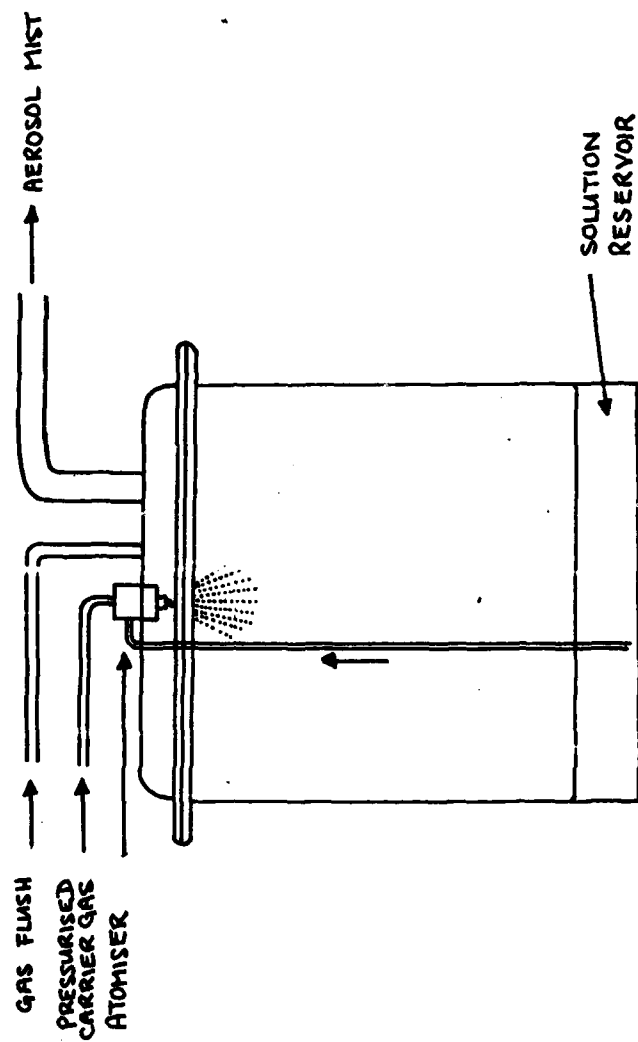


Fig.5.